Abstract

Ever increasing demand for electricity, exploitation of large hydro and nuclear power at remote location has led to power evacuation by long EHV/UHV transmission systems. This thesis concentrates on transient analysis of EHV/UHV transmission systems for improved planning and protection.

In this thesis, the uncontrolled and controlled switching methods to limit the switching surges during energization of 765kV and 1200kV UHV transmission lines are studied. The switching surge over voltages during the energization of series compensated line are compared with uncompensated line. A Generalized Electromagnetic Transients Program has been developed. The program incorporates specific models for studying the effectiveness of various means for control of switching surge overvoltages during UHV transmission line energization and also simulation of various types of faults. Since power grids may adopt next higher UHV transmission level 1200kV, these studies are necessary for insulation coordination as well as transmission line protection relay settings.

A new fault detection/location technique is presented for transmission line using synchronized fundamental voltage and current phasors obtained by PMUs at both ends of line. It is adaptive to fault resistance, source impedance variation, line loading and fault incidence angle. An improved Discrete Fourier Transform(DFT) algorithm to estimate and eliminate the decaying dc component in a fault current signal is proposed for computing the phasors.

The settings for digital distance relays under different operating conditions are

obtained. The relay should operate faster and be more sensitive to various faults under different conditions without loosing selectivity. An accurate faulted transmission line model which considers distributed shunt capacitance has been presented. The relay trip boundaries are obtained considering transmission line model under realistic fault conditions. For different loading conditions ideal relay characteristic has been developed. The obtained trip boundaries can be used for proper settings of practical relay.

An adaptive relaying scheme is proposed for EHV/UHV transmission line using unsynchronized /synchronized fundamental voltage and current phasors at both ends of line. For fault location, the redundancy in equations is achieved by using two kinds of Clarke's components which makes the calculations non-iterative and accurate. An operator for synchronization of the unsynchronized measurements is obtained by considering the distributed parameter line model. The distance to fault is calculated as per the synchronized measurements.

Support Vector Machine (SVM) is used for high speed protection of UHV line. The proposed relaying scheme detects the fault and faulted phase effectively within few milliseconds. The current and voltage signals of all phases at the substation are fed to SVM directly at a sampling frequency of 1.0kHZ i.e 20samples/cycle. It is possible to detect faulted phase within 3msec, using the data window of 1/4th cycle. The performance of relaying scheme has been checked with a typical 765kV Indian transmission System which is simulated using the developed EMTP.